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[COMMITTEE PRINT]

84TH CONGRESS, 2d Session } SENATE

PROGRAM FOR THE REHABILITATION OF THE ALASKA SALMON FISHERIES

REPORT

PREPARED FOR USE OF THE

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE

BY

SENATOR WARREN G. MAGNUSON

JULY 31, 1956

Printed for the use of the Committee on Interstate and Foreign Commerce

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UNITED STATES
GOVERNMENT PRINTING OFFICE
77934 WASHINGTON : 1956

PURCHASED THROUGH
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FOREWORD

Our Alaska salmon production has fallen steadily the past few years, with last year's catch the lowest in 45 years. The decline of this resource, to less than one-half the returns of a good year, represents an annual loss of over $50 million to the industry.

It is for this reason I have had a study made, under the direction of Milo Moore, fisheries consultant to the Committee on Interstate and Foreign Commerce, on ways and means to help Alaska salmon fisheries in addition to the regulatory controls set forth by the Service.

Witnesses testifying at our committee hearings, and other informed persons consulted, are firmly convinced that a program of predator control, stream improvement work, stream and lake fertilization, and direct supplemental feeding of wild salmon fry will be a practical and a beneficial aid in restoring these depleted fisheries.

On April 19, 1956, I submitted a general program and justification for such work to the Fish and Wildlife Service, the Alaska Department of Fisheries, and the Bureau of the Budget for their consideration. I was hoping to have their cooperation and support in securing an emergency fund for the project during the 2d session of the 84th Congress.

The suggested plan called for an appropriation of $700,000 for the 1956–57 fiscal year, and it was recommended that the program be extended over a period of from 4 to 6 years, but it will now be necessary to wait until January 1957 before the program can be initiated. The program would be carried out under policies developed by a committee comprising, as chairman, one of our leading fisheries scientists, a member of the Fish and Wildlife Service, a representative of the Territory of Alaska, and two representatives of the fishing industry.

The committee, appointed by the Government, would for the first time permit leaders of the industry to participate with the Government in a program for fisheries improvement in Alaska. It would bring together in a cooperative effort those most interested in the welfare of these fisheries. Except for our international fisheries programs, which have proved effective, no industry representatives have been recognized to participate directly with the national administration in such planning.

From the testimony of witnesses, and from letters and wires received from hundreds of fishermen and industry leaders, I am firmly convinced that lack of cooperation is chiefly responsible for the present crisis in the Alaska salmon industry.

I believe the practical fisheries program recently enacted in Senate bill S. 3275 which I introduced, plus the plan proposed in this report to assist the propagation and growth of small salmon in our lakes and streams, will advance the rebuilding of our depleted Alaska fisheries to a far greater degree than would be the case under the present planning of the Fish and Wildlife Service.

With the execution of the program as outlined in this report, we will learn from practical experience the added benefits that might result from the use of artificial means to assist the natural growth of wild fish in all parts of the country.

WARREN G. MAGNUSON,
United States Senator.

PROGRAM FOR THE REHABILITATION OF THE ALASKA SALMON FISHERIES

Justification of Alaska Salmon Rehabilitation Program

It is acknowledged that the Alaska salmon fisheries have declined to a point where all interests are concerned in assisting the replenishment of the salmon runs.

Up to the present time, practically all management efforts in Alaska have been directed toward securing adequate escapement of the salmon to the spawning grounds and the principal objective of management appears to be to enforce restrictions upon man alone in his efforts to harvest the natural runs of salmon.

Our early scientists who explored the matter and who studied salmon in lakes and streams in Alaska over 65 years ago told of predation affecting the survival of salmon which was equal to if not far greater than man's efforts in harvesting the runs.

The following statement was made by Mr. Livingston Stone, salmon culturist with the United States Fish Commission, Survey of Alaskan Salmon Rivers, in the year 1889:

> Speaking of conditions of salmon production in the Karluk Lake area: The eggs and young of the red salmon have many enemies and the percentage of fish naturally developed from eggs must be exceedingly small. Every salmon nest has its greedy horde of fresh water sculpins, otherwise known as miller's thumbs, blobs, and bullheads, always in readiness to consume fresh eggs in quantities all out of proportion to their size. The shoal waters around the shores of Karluk Lake and the shallow streams into which the red salmon finds its way for reproduction, contain myriads of these destructive little sculpins. Another source of destruction to the eggs is found in the Dolly Varden trout which is only too common on the spawning grounds of the salmon. This trout consumes large quantities of the fresh salmon eggs. The waters referred to contain also a great many sticklebacks, some of very large size, and it is probable that these little fish destroy eggs.
>
> Chief among the destroyers of the young fish are terns, gulls, ducks, and loons which are very common in that region. I shot some terns and gulls near the south end of Karluk Lake and upon holding them up by the legs small salmon dropped out of their mouths. Toward the end of August, the shallow parts of Karluk River were visited by hundreds of gulls which were feeding upon young salmon. Bears consume large quantities of the breeding fish.

Other enemies of the salmon attack it in the sea. Sharks, hair seals, belugas, and sea lions take their toll.

The report of Livingston Stone, 67 years ago, briefly describes the countless hazards that affect the life of salmon in lakes and streams.

One other serious factor that undoubtedly affects the growth and survival of young salmon is the mineral and organic content of the water in lakes and streams which is necessary to grow plankton, the food of young fish.

The lack of stream and lake fertility may retard seriously the growth of all young fish.

Ordinarily, nature assists in the fertility of the watersheds in various ways: through the decaying carcasses of adult salmon after they have spawned, through organic substances deposited in the streams, and through minerals washed into the waters by erosion of the land.

Often these sources of minerals are lacking in streams, and the survival of fish life in the waterways depends upon there being adequate quantities of such minerals to produce the food supply.

Under modern methods of fisheries management, we know how to rid the waters of many predators upon fish life. We know how to artificially assist the growth of fish life through direct and supplemental feeding and by placing in the waterways balanced minerals to foster the growth of plankton in relation to the volume of water and the amount of available sunlight and warmth.

There is little difference in the requirements for productive farming of upland areas from those which are necessary to obtain the most productiveness from water areas.

The possibilities of increasing our salmon runs by protecting and assisting the growth of spawn and young fish while they are in the lakes and streams compares favorably to securing adequate escapement of adult salmon to the spawning beds.

The success of a program like that hereafter described is beyond the comprehension of the average man and even of some of the fisheries management people, yet in the poor countries of the world people have learned to raise unlimited quantities of food fish in ponds by direct feeding, fertilization and predator control.

New techniques in the artificial hatching of salmon eggs incubated in hatcheries, and the simplified care of young fry reared to the stage where they can be planted in lakes and streams, offer much encouragement as means of establishing new salmon runs.

By freeing lakes of predators or salmon, and by the use of the new type incubator equipment, many small lakes can be utilized as hatchery ponds. Supplemental feeding and fertilization of the lakes make possible the production of small salmon fry on a scale comparable to that of large red salmon lakes which are productive under natural conditions.

The cost of such operations, if they are managed properly, will be only a fraction of the value of the returns to the industry.

Comparative Estimates Based Upon Scientific Knowledge of Natural and Artificial Propagation of Salmon

Natural red salmon egg hatch

Estimated survival from each 2,000 eggs deposited:	
35 percent of eggs deposited (loss 65 percent)	700 eggs.
1 percent to migrating stage (99 percent loss from seed)	20 fish.
1/10 of 1 percent return as adults	2 fish.

Artificial hatching and rearing red salmon

Estimated survival from each 2,000 eggs hatched, 85 percent (15 percent loss) from 1 male and 1 female.	1,700 fish.
Estimated survival reared yearlings, 50 percent	1,000 fish.
Estimated survival return of adults, 2 percent (98 percent loss).	40 adult fish.
Estimated total cost of rearing red salmon for 1 year	50 cents per pound.[1]

[1] 50 yearling salmon equal 1 pound.

Example of hatchery rearing

4,000 adult red salmon will produce	4,000,000 plus eggs.
Estimated cost of rearing for 1 year (50 percent loss).	$20,000 for 2,000,000 salmon fry.
Estimated return of adults to industry (3 percent).	60,000 fish worth $60,000.
Estimated return of adults to hatchery (1 percent).	20,000 fish worth $20,000.

Basic Estimates for Alaska Salmon Rehabilitation Program, 1957–58 Fiscal Year

Predator control, direct feeding and fertilization of lakes and streams in Alaska

(a) Direct feeding of wild fish:	
Supplemental food pellets for wild fish in area (estimated amount equal to rearing 1,000,000 small fry):	
Each feeding, 350 pounds, at 9 cents per pound	$31.50
Freight, at 2 cents per pound	7.00
Distribution by air in Alaska lakes, 2 cents per pound	7.00
Total	45.50
Estimated pellets to feed 1 billion fish in Alaska	45,000.00
Administrative expenses	7,000.00
Total	52,000.00
(b) Predator control for salmon streams in Alaska:	
1. Control of predators in lakes and streams:	
Purchase of equipment and supplies for predator control	41,800.00
Labor, involving the hire of 10 men for 6 months for field operations in execution of predator and control	50,000.00
Travel expense and the hire of small boats and planes	10,000.00
2. Control of predators, hair seals and sea lions:	
Hire of 10 men for 6 months	50,000.00
Supplies and equipment	20,000.00
Travel expense and the hire of small boats and planes	10,000.00
Expense of research to produce repellents to remove predator ducks, birds, and animals from spawning areas	10,000.00
Total	191,800.00

Predator control, direct feeding and fertilization of lakes and streams in Alaska—Continued

(c) Stream and lake fertilization:	
Lake fertilization (estimated per mile of shoreline area), 1,000 pounds. Cost of fertilizer plus freight and air distribution, $150 per ton. Estimated cost of fertilizing 2,500 miles of shoreline	$200,000.00
It is recommended that the annual production of approximately 350 tons of seal meal produced by the Federal Government in connection with fur seal operations in the Bering Sea be allocated and delivered to Kodiak Island, Alaska, for fertilizing lakes, bays, and streams in the area.	
(d) Stream improvement program:	
Cost of construction of fish ways and clearing spawning ground:	
For salmon	100,000.00
Engineering cost	15,000.00
Total	115,000.00
(e) Hatchery program to be operated by Territory:	
Construction of fish hatchery and rearing pond for red salmon	100,000.00
(f) Cost of administration of program	41,200.00
Total, Alaska salmon rehabilitation program, 1957–58	$700,000.00

It is further recommended that this program should be extended over a period of from 4 to 6 years.

EXECUTION OF ALASKA SALMON REHABILITATION PROGRAM

It is recommended that every consideration be given to the adoption of the outlined program and that in carrying it out men be employed to direct the work who have knowledge and experience in administering similar programs.

It is recommended that Congress and the Secretary of the Interior provide for the execution of the Alaskan salmon rehabilitation program as indicated herein under the authority of the Territorial fisheries department and the Fish and Wildlife Service, and that a policy-making board be set up to direct and formulate policies for the general application of the work, by contract or otherwise, comprised of Dr. Lauren Donaldson, head of the University of Washington Applied Fisheries Laboratory, as chairman, a member selected by the Fish and Wildlife Service, a member to represent the Territory of Alaska, and 2 members representing the Alaska salmon industry, 1 of whom shall be actively engaged as a fisherman.

On the basis of the foregoing tentative program and estimates, the Territorial department of fisheries was asked to work out a plan outlining a program of work that might be applied to specified areas in Alaska under their direction. This was accomplished and its report is set out below.

A similar request was made to the Fish and Wildlife Service of the Department of the Interior. The Service approved the objectives of the general plan for the rehabilitation program, and it has prepared estimates and details based upon the general plan outlined in this report. The work which the Service suggests be carried out is also set out below. These suggestions would be applied to areas of Bristol Bay and southeastern Alaska, which are not included in the program suggested by the Territorial department of fisheries.

These action programs are for the planning purposes only. It will be the duty of the proposed policymaking board, referred to above, to evaluate and coordinate these programs and recommend the allocation of funds to obtain the best results.

Estimates for an Alaska Salmon Rehabilitation Program Submitted by the Territorial Department of Fisheries

It was recommended by the Alaska Department of Fisheries, that the sum recommended for the fiscal year 1956–57 in connection with the Alaska salmon rehabilitation program in specified areas be allocated substantially as follows:

Plan and program to be executed by the Alaska Territorial Department of Fisheries

Project A. Predator control on fish-eating species	$100,000
This work would supplement that being done at present by the Alaska Territorial Department of Fisheries and would be conducted in various parts of the Territory. It is proposed to divide the funds as follows:	
Control of mammals (belugas, sea lions, seals, etc.)	40,000
Control of birds (mergansers, gulls, etc.)	15,000
Control of fish (stickleback, sculpins, dollies, etc.)	20,000
Evaluation of the above	10,000
Work on predator repellants (chemical, visual, sonic)	15,000
Project B. Direct feeding of wild fish	25,000
Peronsa Lake on Afognak Island would make an ideal location to see if improvement of red salmon runs could be accomplished by direct feeding. Kitoi Lake near our Kitoi Bay station would serve as a control.	
Project C. Lake rehabilitation	50,000
This would be a program similar to the one in Washington State being carried out by the game department under Clarence Pautzke. However, we would be raising red and silver salmon instead of trout. 8 lakes near the Kitoi Bay station would be used for the work. 4 lakes would be treated with rotenone to eliminate all trash fish and 4 lakes would be controls.	
Project D. Stream and lake fertilization	175,000
It is proposed to work on 2 of the larger lakes on Afognak Island, probably Afognak and Malina Lakes. Kitoi and Little Afognak could be used as controls to evaluate the results.	
Project E. Stream improvement	200,000
Frazer Lake Falls on Kodiak has been selected as the first project. The department already has some preliminary surveys on this and believes it to be practical. Frazer Lake is about 8 miles long by 1 mile wide with an area of approximately 5,000 acres. A 31-foot falls is located a half mile below the outlet of the lake. Adult- and smolt-counting facilities should be incorporated in the fishway.	
Project F. Hatchery	110,000
A station with a capacity of 4–8 million fry should be constructed in the Kodiak-Afognak area to service the various projects being proposed for this general locality. The outlet of Frazer Lake might offer a good location.	
Project G. Administration	40,000
It is believed the above would be sufficient to take care of the above projects.	
Total	$700,000

It is assumed that the same recommendation will be made for the 1957–58 fiscal year.

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PREDATOR CONTROL

Recognition that Alaska's salmon stocks suffer constant attrition through predation by mammals, birds, and fish has been expressed by observers for over half a century. While the stocks were sizable, and even when they were dwindling to alarmingly low levels, this knowledge was accepted with complacency by the administrators of Alaska's salmon resources. This attitude toward predation has only recently been jolted into one of genuine concern, chiefly through the stimulus of the recent grave decline in salmon numbers.

It is true that predator reduction programs have been undertaken from time to time without obvious benefit. In the case of eagle and seal bounties, perhaps little or no benefit did result. In other instances, much good was undoubteldy accomplished, but evaluation was impossible from the mere knowledge of the number of predators destroyed. In more recent years, carefully planned and executed control measures, both in Alaska and elsewhere, have demonstrated the practicality and value of this approach where the predation problem is adequately understood. Fortunately, biologists have accumulated, bit by bit, a considerable store of information about predation and competition that provides a solid, safe foundation for increased control measures. We know from objective scientific research that predation losses are sometimes enormous, and that widely accepted theories of "balance of nature" and "self-limiting predator-prey systems," while pertinent to many situations, do not have universal application. Some of our most costly predation problems certainly can be remedied without the dire consequences forecast by certain people. Underrating the possible adverse effects of inappropriate predator control measures would indeed be foolhardy but within the scope of present knowledge the manipulation of well-understood predator-prey and competition relationships is a valuable management tool that will accomplish much good.

The present need, then is to relieve currently known predation problems. In some cases, as with belugas and gulls, this may best be accomplished without actual destruction of the predators, but rather by repelling or scaring them away from prey concentrations. The methods will vary and new, more effective ones must be developed. Next, it is extremely important that the results of control activities be evaluated. Should actual benefits be falsely attributed to other causes, or vice versa, due to lack of honest evaluation, predator control as a management tool would again suffer a severe setback.

ESTIMATES FOR AN ALASKA SALMON REHABILITATION PROGRAM SUBMITTED BY THE FISH AND WILDLIFE SERVICE

The reduced abundance of salmon in Alaska, which this program is designed to correct, is due chiefly to depletion of red salmon in Bristol Bay and pink salmon in southeastern Alaska. These two areas and the species mentioned, in years of normal runs, have accounted for two-thirds of the total salmon production in the Territory. Restoration of salmon runs capable of producing the long-term average of 5,200,000 cases of canned salmon annually can be achieved only by correcting conditions in these areas.

The Fish and Wildlife Service proposes that this problem be attacked directly in the areas where depletion has been most severe and where

restoration of the runs will reestablish the industry at its former level of productivity. To accomplish this, two action programs are proposed beyond the scope of activities contemplated by presently available funds. These are as follows:

I. AN ACTION PROGRAM FOR THE REHABILITATION OF THE BRISTOL BAY RED SALMON FISHERY—$572,000

The problem

Recognizing that the salmon rivers of Bristol Bay are now producing one-third of their former production, the following program is designed to increase the salmon runs by utilizing all scientific data available at the present time. The following basic assumption is inherent in this approach:

1. The decline of the Bristol Bay red salmon runs has been caused by improper harvesting of the runs and a reduction in the fresh-water survival rate of adults, eggs, and young. (See appendix I for reasoning.)

The cause

1. The spawning escapement may not distribute itself in a normal fashion on the spawning grounds by area or time or both. In this respect the fishery is undoubtedly affecting the survival by harvesting too great a portion of salmon from some spawning segments either by area or time or both. Thus, some favorable spawning beds may lack sufficient spawners or they may not appear at the most propitious time for maximum survival of the eggs and young.

2. Important parts of the spawning escapement into the streams may not successfully spawn. Either man or animals, such as bears or gulls, may be preying upon the escapement. Further, perhaps beaver dams or other barriers reduce the amount of successful egg deposition. Stream bed erosion from excessive rains may have washed out valuable spawning gravel.

3. The eggs may not be hatching in normal amounts because of overcrowding, disease, unfavorable stream conditions, or predators.

4. The young, living 1, 2, 3, or 4 years in the Bristol Bay lakes, find a number of conditions unfavorable for survival:

(*a*) They may be exposed to greater than normal predation in the form of ducks, Dolly Varden char, pike, or lake trout.

(*b*) They may find food scarce because of competitors such as stickleback, grayling, or young trout and Dolly Varden.

(*c*) The fertility of the lake may be reduced by a reduction of the basic inorganic nutrients. An insufficiency of food may not only reduce their numbers directly, but may cause the survivors to remain an extra year in the lakes, thus subjecting them to an additional year of fresh-water mortality and providing greater competition to the younger age classes of salmon coming behind them. (Further discussion in appendix II.)

Corrective measures

These measures can be applied to increase the survival rate in fresh water:

1. Provide for an improved and "normal" escapement of adult red salmon into all five major Bristol Bay rivers (normal with respect to the natural migratory timing of the run).

2. Increase the protection of the adults upstream to the spawning grounds by reducing predation on adults, by eliminating stream barriers, improving the migration routes, and by improving the spawning beds through the elimination of barriers and/or by the erection of check dams to hold spawning gravel where erosion has scoured the streams.

3. By improving access to spawning areas, silting and erosion can be alleviated, thereby improving egg survival. By providing a better distribution of spawning escapement by time as well as space, the eggs will tend to be deposited during the times of least chance for weather extremes which may be fatal to eggs or young. A more normal distribution of escapement will tend to disperse the spawning over a wider range of the spawning grounds, alleviating crowding of spawners and thereby increasing egg survival.

4. The growth and survival in the lakes themselves must be improved to increase survival of the young.

(*a*) Lake predators of all kinds reduced by (1) direct removal; (2) selective poisoning; (3) trapping at inlets and outlets to the lake, since many of the predators move into streams to spawn.

(*b*) Competitors must be reduced by the same means as the predators and by attacking them during spawning periods.

(*c*) The fertility may be increased by introducing inorganic or organic fertilizers into all or portions of the lakes. While this may be very expensive for a lake the size of Iliamna, small traces of certain inorganic fertilizers may be sufficient.

Summary

Assuming, in view of considerable evidence, that the major decline in Bristol Bay salmon runs has been caused by improper harvesting of the adults and a reduction in the survival rate of the salmon during some stages of its fresh-water life, by improving the quality of the escapement, the chance for successful spawning, and the survival rate of eggs and young in fresh water, a rapid improvement in the Bristol Bay runs can be assured.

Appendix I. There has been a reduction in the rate of survival of Bristol Bay red salmon in fresh water

Reasoning: T. A. Barnaby (1950) found a rather constant survival of about 20 percent in the smolts migrating out of Karluk Lake on Kodiak Island. He reasoned that the variations in return of red salmon occurred from changes in survival in fresh water.

Dr. W. F. Thompson, studying the red salmon of the Nushagak River, a Bristol Bay tributary, accurately predicted the 1955 run into this river system on the basis of the downstream counts; i. e., showing that the major variation in survival rate, at least for that brood year, occurred before the downstream migration of smolts.

Predictions by the Oregon Fish Commission of red salmon runs in the Columbia River have been accurate in about 6 of 7 years, despite incomplete data on the smolt downstream migration (indicating a relatively constant rate of survival in the sea). A recent study of all Karluk River red salmon data by Dr. George Rounsefell (as yet unpublished) concludes that the cause of decline of the Karluk red salmon has been a reduction in the rate of survival within the lake.

Appendix II. Total productivity in a lake

Two things probably have happened in Alaska red salmon lakes. First, with a reduction in the numbers of red salmon fry produced, there has occurred a surplus of space and food which is immediately taken up by some other animal, most likely a fish competitor or predator species. Thus, the space or food available for sockeye young may have become permanently reduced. It is very unlikely that the total mass of animals produced within the lake within the year is reduced in this instance. On the other hand, the natural fertility of the lakes may wax and wane or even be trending to a lesser productivity. This lessened productivity may be of natural cause or may be due in part to a lessened amount of protein and minerals deposited in the lake from the ocean via the anadromous salmon. Fertilization experiments of Bare Lake are beginning to show that supplemental fertilization produces great increases in the level of production within the lake.

In all lake systems of Bristol Bay there has been occasional fertilization by deposits of volcanic ash which is high in basic chemical nutrients. There have been none of these deposits in several decades and this may well mean that the fertility of the lake has been at least temporarily reduced.

II. AN ACTION PROGRAM FOR REHABILITATION OF THE SOUTHEASTERN ALASKA PINK SALMON FISHERY—$943,000

The problems

1. Insufficient escapement because of doubled fishing intensity within the past 10 years.
2. Lack of proper distribution due to complex intermingling of the runs to the various rivers on their way to the spawning grounds.
3. Reduction in fresh-water survival due possibly to predators, water fertility, weather cycles, and other natural conditions.
4. Restricted access to potential spawning areas.
5. Increase in logging, hydroelectric power, and industry (a future problem to be met in advance).

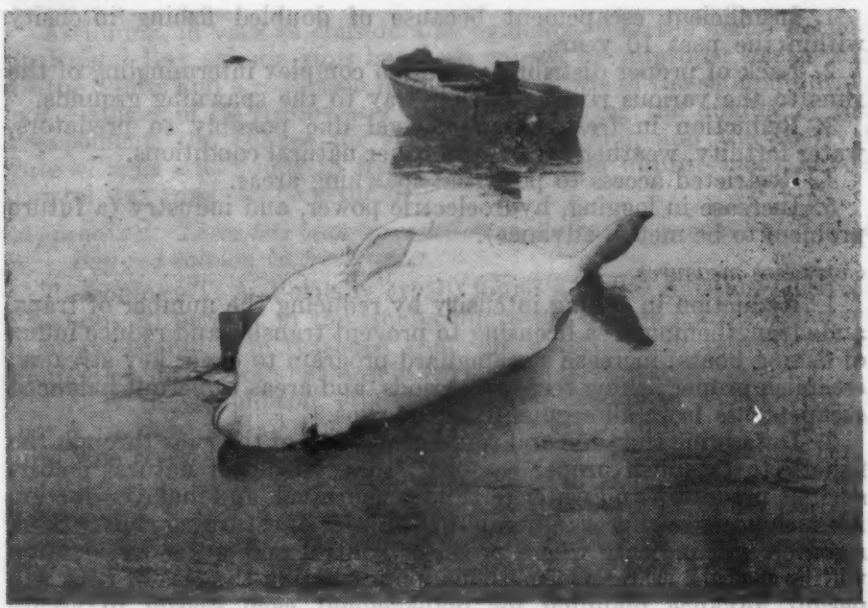
Corrective measures

1. Reduction in fishing intensity by reducing the number of traps, and strengthening area licensing to prevent transfer and reduce influx of fishing boats; increase streamguard program to cover key streams; establish proper fishing seasons, periods, and areas to permit balanced escapements from all segments of the runs.

2. Determine the time and route of passage of the runs through the fishery to establish proper seasons; study effects of natural factors such as predation and water fertility on survival, and make correction for such adverse effects in predicting the size of returning runs. Such research will indicate where predator control and water fertilization will be useful. Effective methods for predicting the size of runs will permit advance planning for management each season to assure adequate escapement and utilize fully the large runs that occur occasionally. Engineering study of restricted spawning areas will determine which may be opened to spawning salmon economically.

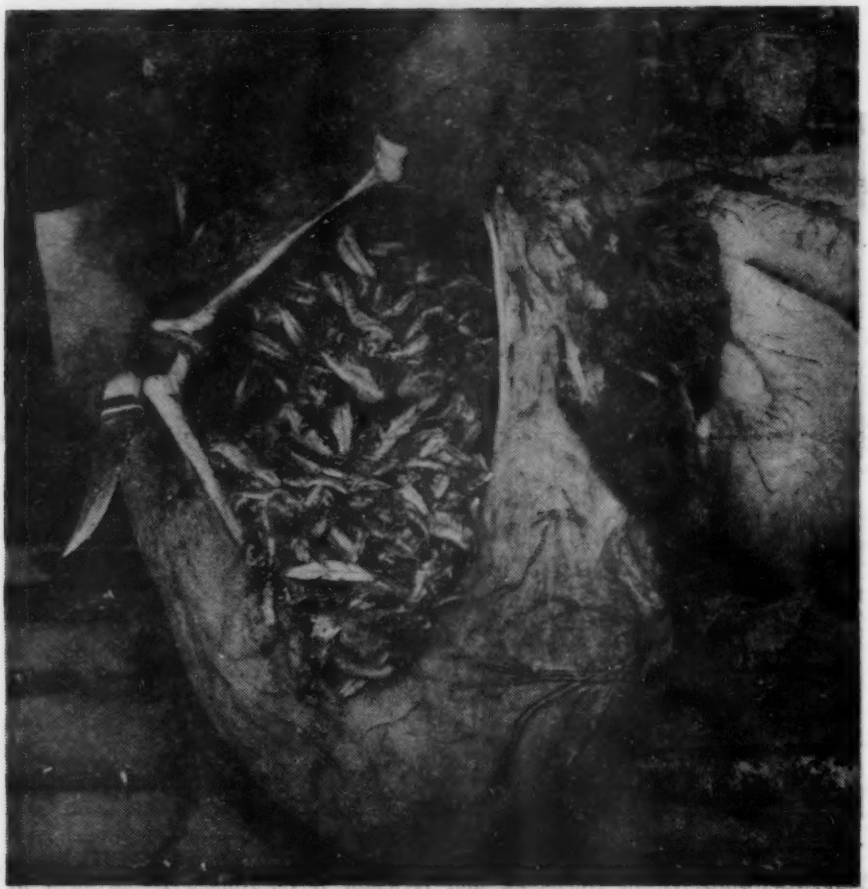
Sea Lion Rocks north of Amak Island.

Aerial photo July 29, 1952
Fisheries Research Institute

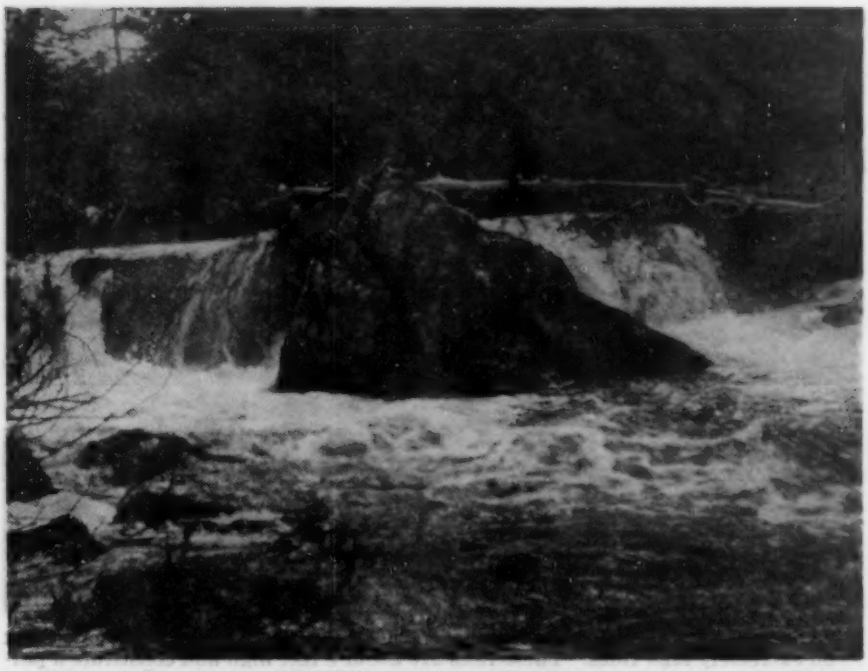


An adult male beluga (#68, taken Aug. 16, 1954). With increasing age, the front flippers would develop a more pronounced curl and lose their dark border. Now 14 feet 11 inches long, this animal might have grown an additional 4 or 5 inches in length. It came from a school of about 1,000 which usually spends the summer in Kvichak and Nushagak Bays.

An adult female beluga (#103, taken July 8, 1955) whose stomach contained 8 adult red salmon in a partially digested condition. From a sample of 78 belugas collected in Nushagak and Kvichak Bays, Alaska Department of Fisheries biologists have calculated that 2.7% in 1954 and 1.0% in 1955 of all adult red salmon present were lost to belugas.

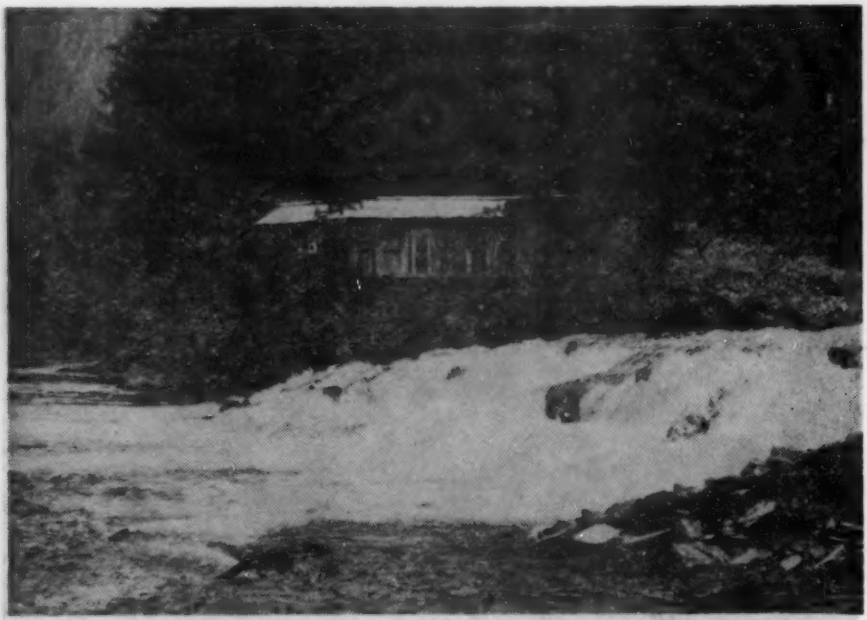


Stomach from male beluga (#86, taken June 4, 1955, in the Kvichak River) showing contents which included 2,798 seaward migrating red salmon, 14 smelt, and 1 stickleback. Based on a sample of 38 belugas taken during the downstream migration, the annual loss of these young red salmon to belugas in the Kvichak River was calculated to be approximately 3,000,000.



(BEFORE) Log jam in Bell Island stream, Southeastern Alaska. Looking upstream.

(AFTER) Bell Island stream, Southeastern Alaska. Removal of the log jam at this point in the stream greatly extended the available spawning ground in this stream.



(BEFORE) Falls in Naha River, Southeastern Alaska, impassable to salmon except on extremely high tides. These falls are about 8 feet high and constitute a partial barrier to estimated escapements of 300,000 pink salmon. Forest Service observation station in background.

(AFTER) Naha River showing completed cut around left side of falls. Although the fish ladder was not completed, about 300,000 salmon used the cut to ascend to spawning grounds above the falls in the fall of 1949.

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